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English translation of Japanese Patent No. 2842262

Date of Issue: December 24, 1998
Date of Registration: October 23, 1998
Application No. 6-315660
Application Date: November 25, 1994
Laid-Open Publication No. 8-147879
Laid-Open Publication Date: June 7, 1996
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[Title of the Invention] OPTICAL DISC RECORDING DEVICE

[Claims]

1. An optical disc recording device receiving a data to be recorded from a host computer, forming a predetermined format of CD-WO standard, MD standard or MD data standard for a data of predetermined unit section through a buffer memory, performing interleaving for data of the relevant unit section, and continuously recording the data of a plurality of unit sections, wherein the optical disc recording device includes a sequence controller executing a recording sequence of:

when continuously recording the data of the plurality of unit sections, determining whether substantially an entire data of the next unit section is stored in the buffer memory at a timing before recording a data of a next section of the unit section; and

if substantially the entire data of a next unit section is stored, continuing recordation to successively record the data of the next unit section after the present unit section; and

if substantially the entire data of a next unit section is not stored, temporarily interrupting recordation after

recording of the present unit section is finished, suspending recordation until substantially the entire data of the next unit section is stored in the buffer memory, and resuming recordation of the next unit section and on from where recording was interrupted.

2. The optical disc recording device as claimed in claim 1, wherein the sequence controller further executes, when recording the data of the first unit section, a sequence of starting recording of a data of the first unit section after substantially an entire data is stored in the buffer memory.

[Detailed Description of the Invention]

[Field of the Invention]

The present invention relates to an optical disc recording device that records data in accordance with a CD-WO (CD Write Once) standard, an MD (Mini Disc) standard or an MD data standard, which optical disc recording device and when a data transmitted from a host computer is received in a buffer memory and interleaving is performed on the data for every predetermined unit section to continuously record a plurality of unit sections, prevents buffer empty (state in which a buffer memory becomes empty) from occurring in the middle of recording.

[Background Art]

Generally, in the CD-WO or MD disc recording system, the data (host data) transferred from a host computer 10 is received by a buffer memory 14 in an optical disc recording

device 12, and then recorded on an optical disc (CD-WO disc or MD disc), as shown in Fig. 2. During recording, the buffer memory 14 sequentially reads in a new data transferred from the host computer 10 and sequentially reads out and writes in the old data into the optical disc 16 at a constant clock.

A recording format of CD-WO includes a Track at Once, in which writing is performed by one track or one group of data (corresponds to one song in CD Digital Audio (CD-DA)) at a time, and an Incremental Writing, in which writing is performed by "packets" in the track . The Incremental Writing is further classified into a fixed packet in which a size (data length or amount) of one packet is fixed and a variable packet in which the data amount of one packet is varied. In the Track at Once, recording is performed with the track as the unit, as shown in Fig. 3(a). The format of the track includes Run-out (RO), Link, Run-in (RI) blocks as writing-seam period, and Pre-gap block as well as User Data (UD) block are arranged in between the Run-in block and the Run-out block. In the Incremental Writing, recording is performed with the packet as the unit, as shown in Fig. 3(b). The format of the packet includes Run-out, Link, Run-in blocks as writing-seam period, and the User Data block is arranged in between the Run-in block and the Run-out block.

In the above formats, the User Data is the data (host data) transferred from the host computer 10. The Link, Run-in, Pre-gap, and Run-out blocks are generated in the optical disc recording device 12. The Link block is a block erased by the writing-seam and is bounded by one sector. The Run-in block is a running section of a servo for receiving the User Data and consists of four sectors (RI-1 to RI-4). When

each sector of the User Data is interleaved with Cross Interleave Reed-Solomon Code (CIRC) and is distributed and recorded, the Run-out block is used to record the distributed data without extending into the Link block. There are 2 sectors of Run-out block (RO-1 and RO-2). Track Description Block generated within the disc recording device is written into the Pre-gap block.

As shown in Fig. 4, one sector (= frame) consists of 98 EFM frames (1 EFM frame is 24 bytes). When interleaving is performed with CIRC, the data of 1 EFM frame is distributed and recorded to an EFM frame 108 EFM frames ahead at the most. Therefore, the data in the last sector of the User Data is recorded up to the second sector of the Run-out block (RO-2).

In the MD standard and the MD data standard, there are two sectors of Run-in block, and Advanced Cross Interleave Reed-Solomon Code (ACIRC) that performs a similar interleaving as CIRC is used in place of CIRC. The recording format is the same as the fixed packet of CD-WO.

[Problems That the Invention are to Solve]

As shown in Fig. 2, in a system in which the data transferred from the host computer 10 is received by a buffer memory 14 and then recorded on an optical disc 16, when a plurality of unit sections (track or packet) is continuously recorded, the amount of data in the buffer memory 14 will always be constant if the data transfer speed from the host computer 10 to the buffer memory 14 is the same as the writing speed of the data from the buffer memory 14. However, if the data process speed of the buffer memory

14 changes (writing speed from the buffer memory 14 is always constant), the amount of data in the buffer memory 14 also changes. If the data process speed of the host computer 10 is delayed, the amount of data in the buffer memory 14 gradually decreases, and once all the data is written, the buffer memory 14 becomes empty or enters a state of buffer empty.

In a recording format of for example, a hard disc drive in which interleaving is not performed, since the logic sector of the host data and the physical sector of the data recorded on the disc corresponds one to one as shown in Fig. 5(a), even if buffer empty occurs at for example, the fifth sector (UD-5), the recording is suspended until the data of the sixth sector (UD-6) and onward is accumulated in the buffer memory. The finishing position of the fifth sector (UD-5) is then sought and the sixth sector and onward is written with seam.

However, in the CD-WO format or the MD or MD data format in which interleaving is performed, the logic sector before recording (before interleave) and the physical sector after recording (after interleave) does not correspond one to one as shown in Fig. 5(b). Thus, if for example, the buffer empty occurs in the fifth sector (UD-5), the data of the fifth sector (UD-5) must be continuously written to two sectors ahead (RO-1). Thus, even if the data of the sixth sector (UD-6) is stored in the buffer memory 14 and is in a state to be written, the position on the disc corresponding to UD-6 and RO-1 is already recorded on, and the data of the sixth sector (UD-6) can no longer be written from the position of the logic sector (UD-6).

The present invention proposes an optical disc recording device that alleviates the above problems of the prior art, and that prevent buffer empty from occurring in the middle of recording when the data from the host computer is received in the buffer memory, and interleaving is performed on the data for every predetermined unit section to perform recording in accordance with CD-WO standard, MD standard or MD data standard.

[Means for Solving the Problems]

The invention cited in claim 1 is an optical disc recording device receiving a data to be recorded from a host computer, forming a predetermined format of CD-WO standard, MD standard or MD data standard for a data of predetermined unit section through a buffer memory, performing interleaving for data of the relevant unit section, and continuously recording the data of a plurality of unit sections. The optical disc recording device includes a sequence controller executing a recording sequence of, when continuously recording the data of the plurality of unit sections, determining whether substantially an entire data of the next unit section is stored in the buffer memory at a timing before recording a data of a next section of the unit section. If substantially the entire data of a next unit section is stored, recording is continued to successively record the data of the next unit section after the present unit section. If, on the other hand, substantially the entire data of a next unit section is not stored in the buffer memory, recording is temporarily interrupted after recording of the present unit section is finished, and is suspended until substantially the entire data of the next unit section is stored in the buffer memory. Recording of

the next unit section and on is resumed from where recording was interrupted.

The invention cited in claim 2 includes the optical disc recording device, in which the sequence controller further executes, when recording the data of the first unit section, a sequence of starting recording of a data of the first unit section after substantially an entire data is stored in the buffer memory.

[Operation]

According to the invention cited in claim 1, at a timing right before the start of recording of a unit section (one packet in Incremental Writing and one track in Track at Once) on which interleaving is performed, the recording sequence controller detects whether substantially an entire data of a next unit section is stored in the buffer memory. If substantially the entire data is stored, recording is continued, and if not, recording is interrupted, and is suspended until substantially the entire data is stored to resume recording. In this way, buffer empty is prevented from occurring in the middle of recording the unit section.

According to the invention cited in claim 2, during recording of a data of a first unit section, the recording sequence controller waits until substantially an entire data of the relevant first unit section is stored in the buffer memory to start recording of the first unit section, and thus recording is properly performed from the data of the first unit section.

[Embodiments]

One embodiment of the present invention will now be described. The following description explains a case of recording in Incremental Writing with a fixed packet size using the CD-WO method. Here, one packet corresponds to one unit section.

Fig. 1 is a diagram showing a system configuration of an optical disc recording system according to the present invention. This system is a system that can optionally set between a mode to continuously record or a mode not to continuously record the packet in an agreement made between the host computer 10 and the optical disc recording device 12 (CD recorder). The following description is based on the assumption that a mode for continuous recording is set.

The host computer 10 generates a data (user data) to be recorded on an optical disc, and continuously outputs a data of a plurality of packets to a connecting cable 20 via an interface portion 18. SCSI, IDE and the like are used for the interface. The data sent through the connecting cable 20 is input to a CD recorder 12 (optical disc recording device). In the CD recorder 12, the input data is received in an interface portion 22 and is sequentially stored in a data buffer 14 (buffer memory).

The data buffer 14, in response to a command from a system controller 24, sequentially overwrites and stores the input new data to an address where the oldest data is stored, and sequentially reads out and outputs the stored data starting from the oldest data at a constant clock. The data buffer 14 has a capacity to store a user data amount greater than one packet. In a format forming/EFM modulator

26, an EDC (Error Detection Code) and an ECC (Error Correction Code) is added to the data read out from the data buffer 14, and Link, Run-in, and Run-out blocks are further added thereto, to form a packet format shown in Fig. 3(b) (packet length is fixed). The data is then EFM modulated and output. The EFM modulated data is supplied to an optical head 30 via a servo controller 28. A laser diode modulator circuit (included in the servo controller 28) performs a laser power control (ALPC: Automatic Laser Power Control), a seek control and the like in response to a command from the system controller 24. Further, the laser diode modulator circuit switches the laser power in accordance with the recording mode/reproducing mode.

During the recordation mode, the optical head 30 modulates a laser beam 32 set to the recording power based on the input EFM signal and exits the beam, forms a pit on a recording face of the optical disc 16 and records the EFM signal. During the reproducing mode, the optical head 30 irradiates the laser beam 32 set to the reproduction power onto the recording face of the optical disc 16 and reads out from the pit.

A data amount detector 34 detects, as needed, the amount of data stored (amount of data read-in but not yet read-out) in the data buffer 14 during the recording mode. Such data amount can be detected as, for example, a difference between the read-out address and the write-in address of the data buffer. During the recording mode, the system controller 24, functioning as a sequence controller, monitors the detected value of the data amount detector 34 at a predetermined timing before recording of each packet is finished, and determines whether the entire data or

substantially the entire data of the next packet is stored in the data buffer 14. As shown in Fig. 6, the sequence controller 24 has, as a fixed reference value, a value of data amount corresponding to one packet length, a value greater than one packet length, or a value slightly less than one packet length. If the detected value of the data amount is greater than the reference value (Fig. 6 (a)) at a predetermined timing before the recording of the present packet is finished (e.g., timing right before recording of the present packet is finished), the data of the next packet following the present packet is successively recorded.

If the detected value of the data amount is less than the reference value (Fig. 6 (b)), the recording is interrupted after the recording of the present packet is finished (read-out from data buffer 14 is stopped, and the laser power is lowered to below the recording level), and is resumed after the data amount reaches the reference value. When recording the first packet, the sequence controller 24 starts the recording after the data amount greater than the reference value is stored in the data buffer 14. In this way, the data buffer is prevented from becoming buffer empty.

Fig. 7 shows one example of a sequence control executed by the sequence controller 24 during the recording mode. First, a command to start recording is issued (S1), and then determination is made whether the data amount greater than the reference value is stored in the data buffer 14. If the data amount greater than the reference value is stored, recording starts (S3). During recording, determination is made whether a timing right before recording of the present packet is finished has been reached or not (S4). If such

timing has not been reached, the recording is continued (S5). The recording is continued until the above predetermined timing is reached, and determination is then made whether the data amount greater than the reference value is stored in the data buffer 14 (S6). If the data amount greater than the reference value is stored, the next packet is successively recorded (S7). If, however, the data amount of the next packet greater than the reference value is not stored in the data buffer 14, the recording is interrupted after the recording of the present packet is finished (S8). Determination is then made whether recording of all the packets is finished (S9). If recording of all the packets is finished, recording is terminated (S10). If the recording of all the packets is not finished, recording is suspended until the data amount greater than the reference value is stored (S11) to resume recording (S12).

Fig. 8 shows an example of actual recording according to the sequence control of Fig. 7. (i) shows a state in which the recording of packet B, successively recorded after packet A by the optical head 30, is close to finish. Here, if the data amount of the data buffer 14 is greater than the reference value, packet C is successively written after packet B is recorded with a data structure including the Link block without performing the seek operation for writing-seam. If the data of the data buffer 14 is below the reference value, as shown in (ii), the recording is interrupted after recording of packet B is finished and is suspended until the data amount of the data buffer 14 is greater than the reference value. The seek operation is then performed and the packet C and so on is written with seam after packet B as shown in (iii).

[Effect of the Invention]

As stated above, in the invention cited in claim 1, the recording sequence controller detects whether substantially the entire data of the next unit section is stored in the buffer memory at a timing right before the start of recording of a unit section (one packet in Incremental Writing, and one track in Track at Once) on which interleaving is performed. If substantially the entire data of the next unit section is detected, the recording is continued, and if not detected, the recording is interrupted and is suspended until the substantially the entire data is stored to resume recording. This prevents buffer empty from occurring in the middle of recording the unit section.

In the invention cited in claim 2, when the recording sequence controller records the data of the first unit section, the recording of the data of the first unit section starts after substantially the entire data of the first unit section is stored in the buffer memory, and thus recording can be properly performed from the data of the first unit section.

[Brief Description of the Drawings]

Fig. 1 is a diagram showing a system configuration of one example of the present invention.

Fig. 2 is a diagram showing an outline of an optical disc recording system.

Fig. 3 is a diagram showing a recording format of CD-WO.

Fig. 4 is a diagram showing a recording format of a user data in accordance with CD-WO or MD or MD data

standard, and a distributed state of the user data as a result of interleaving.

Fig. 5 is a diagram showing writing-seam of data when interleaving is performed.

Fig. 6 is a diagram showing writing-seam of data when interleaving is not performed.

Fig. 7 is a flow chart explaining one example of a sequence control executed by a sequence controller of Fig. 1.

Fig. 8 is a diagram showing a recording operation according to the sequence control of Fig. 7.

[Description of the Reference Numbers]
10…host computer, 12…optical disc device, 14…data buffer (buffer memory), 16…optical disc, 24…system controller (sequence controller)